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PRELIMINARY TESTS WITH METHYL BROMIDE AND DICHLORVOS AS FUMIGANTS FOR *BOOPHILUS* SPP. TICKS AT QUARANTINE STATIONS

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PRELIMINARY TESTS WITH METHYL BROMIDE AND DICHLORVOS AS FUMIGANTS FOR *BOOPHILUS* SPP. TICKS AT QUARANTINE STATIONS

By W. J. Gladney¹

ABSTRACT

Fumigating engorged female ticks (*Boophilus annulatus* and *Boophilus microplus*) with methyl bromide gas for 15 minutes in metal drums prevented the ticks from laying eggs (caused 100 percent female mortality). The effectiveness of dichlorvos strips (20 percent active ingredient) depended on temperature and length of exposure: at 1° to 6° C, tick control (an estimate based on the decrease in the reproduction of treated ticks when compared to the reproduction of untreated ticks) ranged from 16 percent after 1 hour of fumigation to 64 percent after 24 hours; at 29° to 34° C, control ranged from 36 percent after 1 hour of exposure to 81 percent after 24 hours. Technical dichlorvos afforded consistently poor control (0 to 25 percent) at all temperatures and exposures tested. In limited tests, immersion of engorged female *B. annulatus* in saturated NaCl solutions also provided consistently poor control (0 percent after 5 minutes to 27 percent after 1.5 hours).

INTRODUCTION

The importation into the United States of hunting trophies from Mexico poses a problem for Federal animal health officials. Occasionally, Animal Plant and Health Inspection Service (APHIS) personnel at border inspection stations find that such items as deer hides and heads are infested by ticks. Because APHIS, an agency of the U.S. Department of Agriculture (USDA), is charged with enforcing quarantine regulations to prevent importation of *Boophilus* spp. ticks into the United States, inspection personnel need a suitable and reliable technique for killing all *Boophilus* spp. females.

At present, APHIS has no dependable method for killing *Boophilus* spp. ticks on trophies. Some-

times trophies are packed inside plastic bags with a saturated NaCl solution to kill ticks, but the effectiveness of this treatment is unknown. Many ports of entry along the United States-Mexican border are small facilities with limited personnel who are not experienced in handling control chemicals. Also, rapid treatment of trophies is necessary so that hunters returning to the States will be detained for as little time as possible. Therefore, APHIS personnel need a simple, safe, rapid, and effective technique for killing all *Boophilus* spp. females that may be attached to trophies.

APHIS requested that the Agricultural Research Service (ARS) do limited experimental testing to determine the effectiveness of dichlorvos and methyl bromide (MeBr) in the fumigating and killing of female *Boophilus* spp. ticks. Little information is available regarding the efficacy of fumigants against ticks, and no

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information is available on the efficacy of dichlorvos vapors on engorged female *Boophilus* spp. ticks. Barnett and Parsons² fumigated bales of hay infested with several species of ticks with MeBr and obtained variable results. Roth³ obtained 100 percent control of unengorged adult *Rhipicephalus sanguineus* (Latreille) (brown dog tick) with MeBr in fumigation drums.

Reported here are results of preliminary tests with dichlorvos and MeBr against engorged females of *Boophilus annulatus* (Say) and *B. microplus* (Canestrini). All tests were conducted at a sublaboratory of the U.S. Livestock Insects Laboratory (ARS) at Nuevo Laredo, Tamaulipas, Mexico, during 1973.

MATERIALS AND METHODS

From 1964 until 1974, we maintained colonies of *B. annulatus* and *B. microplus* on cattle at Nuevo Laredo for use in spray or dipping tests with tick-infested cattle, in laboratory dipping tests, and in basic biological studies. Drummond et al.⁴ have described in detail the rearing procedures and handling methods used with the ticks. Engorged female ticks available from infestations established for the usual insecticidal tests were used in the fumigation tests reported here.

Test 1

In early January of 1973, fresh hides of white-tailed deer, *Odocoileus virginianus* (Boddaert), were available from a local slaughterhouse. We obtained three hides weighing between 1.71 and 2.12 kilograms from the slaughterhouse.

Groups of 10 female *B. annulatus* were weighed and placed inside specially constructed screen wire cages of 1- by 1-millimeter mesh copper screen. The cages were 9.5 centimeters long and 2.5 centimeters in diameter. After the females were placed inside, the cages were stoppered with a plastic No. 12 Caplug. A total of 18 cages were used, with 10 ticks in each cage.

² Barnett, S. F., and Parsons, B. T. 1963. The control of ticks on fodder and bedding using methyl bromide. *Vet. Rec.* 75: 1213-1215.

³ Roth, H. 1973. Fumigants for quarantine control of the adult brown dog tick: Laboratory studies. *J. Econ. Entomol.* 66: 1283-1286.

⁴ Drummond, R. O., Graham, O. H., Ernst, S. E., and Trevino, J. L. 1967. Evaluation of insecticides for the control of *Boophilus annulatus* (Say) and *B. microplus* (Canestrini) [Acarina: Ixodidae] on cattle. *Proc. 2d Int. Congr. Acarol.*, pp. 493-498.

Three 208-liter (55-gallon) drums were used as fumigation chambers. The outer rims of the drum lids were lined with weather stripping to create an airtight seal when the lids were secured on the drums with metal rim straps.

A special false bottom was constructed of a No. 9 flattened expanded metal (hole size, 1.9 by 3.8 centimeters) to go inside the first drum. The false bottom was 54.6 centimeters in diameter; it fit just inside the 57.1-centimeter-diameter drum and was supported by three 20.3-centimeter-high legs which rested on the bottom of the drum. This circular metal grate supported a deer hide above a 1-liter beaker containing technical dichlorvos which rested on the bottom of the drum.

A metal hook was soldered to the center of the lid of the second drum so that dichlorvos strips⁵ could be suspended by wires from the hook. No special modifications were made on the third drum, which served as a control.

In the first drum, 45 grams of technical dichlorvos was poured in the 1-liter beaker; in the second drum, two 20 percent dichlorvos strips (total weight, 225 grams) were suspended from the metal hook; the third drum received no treatment.

One deer hide was placed in each drum, and three cages of engorged females were folded in the center of each hide so that the cages were completely covered with the hairy side of the hide. Three other cages were placed directly on top of the flesh side of each hide. Thus, a total of six cages were placed in each of the three drums. Timing of the test began when the metal lids were secured to the tops of the drums.

Drums were opened at the end of 1, 4, and 24 hours of exposure, and one cage was removed from both the top and the middle of each hide after each exposure period. All fumigation tests were conducted in open-sided stalls with a wooden roof so that the drums were exposed to ambient temperatures that ranged from 1° to 6° C at normal atmospheric pressure.

Immediately after removal from the drums, the 10 females in each cage were transferred to a labeled 8-dram glass vial and placed in a constant-temperature chamber (27° C and about 85

⁵ No-Pest Strip Insecticide, Shell Chemical Co., San Ramon, Calif. 94583 (active ingredients: 18 percent dichlorvos, 2 percent related compounds; 80 percent inert ingredients).

percent relative humidity). After the females completed oviposition, their eggs were removed, weighed, and returned to the chamber. After hatching of eggs was complete, the percentage of egg hatch was estimated.

The estimated reproduction (ER) was calculated for each group of females by the formula

$$\frac{\text{g eggs}}{\text{g } \varnothing} \times \text{hatch} \times 20,000 = \text{ER}$$

where g eggs = weight of eggs, in grams,
 g \varnothing = weight of females, in grams,
 % hatch = percentage of eggs laid that hatch,
 and 20,000 = a constant, the number of eggs in a 1-gram mass.

Percentage of control for each treatment was then calculated by the formula

$$\frac{\text{untreated ER} - \text{treated ER}}{\text{untreated ER}} \times 100 = \% \text{ control.}$$

Test 2

In mid-June of 1973, a second test was conducted in which dichlorvos strips, technical dichlorvos, and MeBr gas were evaluated. Fresh deer hides were not available at that time of year so the test was conducted in a manner similar to that of test 1 except that cages of females were placed inside the drums without wrapping them in deer hide. Also, an additional exposure time of 2 hours was evaluated.

Dichlorvos, both in 20 percent strips and as a technical liquid, was tested against *B. microplus* females by placing the two formulations inside the fumigation drums as in test 1. The number of replications (10 females per cage) per treatment and exposure time ranged from 2 to 6. Only one replication per exposure time was run for the untreated controls.

A soil fumigant contained in cans as a liquid under pressure was the source of MeBr.⁶ A special hose with a metal adapter was affixed to each can, puncturing the can. A valve at the junction of the adapter and the can kept the fumigant from being released as a gas. The hose was then inserted into a fumigation drum through a small slit between the lid and upper rim of the drum and the valve was opened, re-

leasing the gas into the drum for either 15 seconds or 1 minute.

Cages containing the female ticks were placed inside the drums immediately before the gas was released and were removed from the drums immediately after their exposure time was complete. Protective equipment (respiratory mask, eye goggles, and rubber gloves) was worn by the investigator while the gas was introduced into the drums and while females were being removed from the drums. With *B. microplus*, six cages of females were exposed to the MeBr gas for 15 minutes, and six additional cages were exposed for 1 hour. With *B. annulatus*, four cages were exposed for 1 hour. Temperatures during test 2 ranged from 29° to 34° C. Females were maintained and ER for each group was computed as in test 1.

Test 3

In this brief test, saturated NaCl solution was evaluated for its effectiveness in the control of reproduction of female *B. annulatus*.

NaCl crystals were stirred into 100 milliliters of water until no more of the salt would go into solution and a residue of the crystals remained in the bottom of 135-milliliter ice cream cups. Ten females were placed in each of four different cups and exposed to the solutions for 30 seconds, 5 minutes, 1.5 hours, or 2 hours. Ten control females were placed in untreated water for 2 hours. Females were allowed to air-dry by confining them on paper towels before they were placed in vials. The vials were placed in constant-temperature chambers as in test 1, and ER was computed for the females as in tests 1 and 2.

RESULTS

Test 1

Table 1 shows that dichlorvos vapors from the strips provided a higher level of control of ER than did the technical liquid. The highest level of control was obtained with ticks located on top of the deer hide exposed to the strips for 24 hours. Level of control by strips was greatly reduced at exposure times of less than 24 hours and was less for ticks folded inside the deer hides than for ticks on top of the hide. Control provided by technical liquid was extremely low for all exposure times and for both cage locations. Low ambient temperatures that prevailed during test 1 probably accounted for the low level of

⁶ Pestmaster Soil Fumigant-1, Michigan Chemical Corp., Chicago, Ill. (active ingredients 98 percent MeBr, 2 percent chloropicrin).

TABLE 1.—*Reproduction of engorged female Boophilus annulatus after exposure to technical dichlorvos or dichlorvos strips in fumigation drums*

Formulation and cage position	Exposure (hours)	Weight of 10 ♀ (grams)	Weight of total egg masses (grams)	Hatch (pct of eggs laid)	Reproduction	
					ER ¹	Pct of control
Strip:						
On top of deer						
hide	1	3.06	1.635	85	9,083	16
Do	4	3.58	1.994	90	10,026	11
Do	24	3.12	.632	95	3,849	64
Covered by						
deer hide	1	3.30	1.810	90	9,873	12
Do	4	3.36	1.989	95	11,247	0
Do	24	3.36	1.789	85	9,052	21
Technical:						
On top of deer						
hide	1	3.49	2.027	90	10,454	4
Do	4	3.26	1.876	95	10,934	3
Do	24	3.51	1.904	97	10,524	2
Covered by						
deer hide	1	3.27	1.748	95	10,157	9
Do	4	3.44	2.005	90	10,491	0
Do	24	3.25	1.632	95	9,541	17
Control:						
On top of deer						
hide	1	3.19	1.819	95	10,834	..
Do	4	3.28	1.913	97	11,315	..
Do	24	3.41	1.882	97	10,707	..
Covered by						
deer hide	1	3.61	2.130	95	11,211	..
Do	4	3.19	1.827	80	9,164	..
Do	24	3.39	2.046	95	11,467	..

¹ ER = Estimated reproduction.

control observed since the vaporization and insecticidal activity of dichlorvos are reduced at lower temperatures.

Test 2

Table 2 shows a direct exposure time-activity relationship for dichlorvos strips; the longer the exposure time, the greater the percentage of control. A higher level of control provided by strips was observed in test 2 than in test 1, apparently due to the higher ambient temperatures that prevailed during test 2. Also, as in test 1, technical dichlorvos provided a lower level of control than did the dichlorvos from strips. A fumigant containing 98 percent MeBr was 100 percent effective at various exposure times against both species of female *Boophilus*.

Test 3

The data in table 3 show the relative ineffectiveness of saturated NaCl solutions for control

of female *B. annulatus*. Exposure times of 5 minutes or less had virtually no effect on the reproduction of this species, while exposure times of 1.5 to 2 hours provided very slight control of ER.

CONCLUSIONS

MeBr fumigation was by far the most satisfactory treatment tested from the standpoint of both minimum required exposure time and effectiveness of the chemical in the control of ticks. Fumigation with MeBr requires the use of safety equipment such as gas masks, eye goggles, and rubber gloves by personnel conducting the operation. Fumigation with this gas should be done outdoors.

Technical dichlorvos in drums would not be satisfactory for the fumigation of hunting trophies at ambient temperatures because of the low level of control observed with this formula-

TABLE 2.—*Reproduction of engorged female Boophilus spp. ticks after exposure to dichlorvos strips, technical dichlorvos, or MeBr gas in fumigation drums*

Treatment, species, and formulation	Repliations	Exposure (hours)	Average total ♀ weight per replication (grams)	Weight of total egg masses, average per replication (grams)	Average hatch (pct of eggs laid)	Reproduction	
						Average ER ¹	Average pct of control ²
<i>Dichlorvos, B. microplus:</i>							
Strip	6	1	3.15	1.164	79	5,995	36
Do	4	2	3.03	.964	88	5,501	47
Do	2	4	3.22	.642	88	3,456	66
Do	2	24	3.08	.441	58	1,616	81
Technical	6	1	3.04	1.516	95	9,455	0
Do	4	2	2.86	1.529	90	9,620	6
Do	2	4	3.11	1.218	98	7,686	25
Do	2	24	3.17	1.574	95	9,443	0
Control	1	1	3.05	1.504	95	9,369	..
Do	1	2	2.96	1.552	98	10,277	..
Do	1	4	3.17	1.655	98	10,233	..
Do	1	24	3.23	1.391	98	8,441	..
<i>MeBr, B. microplus:</i>							
Gas ³	6	1	3.01	0	0	0	100
Do ⁴	6	.25	3.13	0	0	0	100
Control	1	1	3.00	1.786	95	11,311	..
Do	1	.25	3.35	1.612	95	9,143	..
<i>MeBr, B. annulatus:</i>							
Gas ³	4	1	2.96	0	0	0	100
Control	1	1	2.79	1.372	80	7,868	..

¹ Estimated reproduction.

² Based on average treated ER and untreated ER.

³ 1 minute elapsed while gas traveled from the can into the drum.

⁴ 0.25 minute elapsed while gas traveled from the can into the drum.

TABLE 3.—*Reproduction of engorged female Boophilus annulatus dipped in saturated NaCl solution*

Time in solution	Weight of 10 ♀ (grams)	Died without ovipositing	Weight of total egg masses (grams)	Hatch (pct of eggs laid)	Reproduction	
					ER ¹	Pct of control
30 seconds	2.77	2	1.372	95	9,411	3
5 minutes	2.87	1	1.507	95	9,977	0
1.5 hours	3.49	1	1.659	75	7,130	27
2 hours	3.23	3	1.346	95	7,918	19
2 hours ²	3.17	0	1.714	90	9,733	..

¹ Estimated reproduction.

² Controls in untreated water.

tion in both tests 1 and 2. Dichlorvos strips may be used to achieve a relatively high level of control if ambient temperatures are moderately high, exposure time can be long (>24 hours),

and hides are placed so that the outer skin is fully exposed to the vapors.

Packing hides in a saturated NaCl solution would not be a satisfactory treatment for control of *Boophilus* females.

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